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## **TITLE**

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Rugged Terrain Robot

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## **CROSS REFERENCE APPLICATION**

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This application is a non-provisional application

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claiming the benefits of provisional application no.

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60/416,973 filed 10/08/2002.

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## **FIELD OF THE INVENTION**

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The present invention relates to a reconnaissance

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robot. More specifically, it relates to a robotic rugged

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terrain apparatus, which operates in a rolling mode to

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traverse rugged terrain or in a stair-climbing mode to climb

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stairways and extreme terrain. The apparatus can carry

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various communication devices, sensors and payloads for use

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by police, firemen, soldiers, rescue or other applications

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where a direct entry by a human may not desirable until an

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area is reconnoitered.

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## **BACKGROUND OF THE INVENTION**

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A potentially hostile site situation can be

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complex as deadly threats may lurk in unseen areas. The

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complexity and density of urban environments adds to the

1 probability of posing deadly threats in areas that cannot be  
2 easily reconnoitered. In particular field circumstances  
3 where police, firemen, swat teams, soldiers, rescue  
4 personnel, or other search and/or rescue operations are  
5 employed, it is important to have a forward reconnaissance  
6 apparatus ahead of the search or rescue team. In some  
7 circumstances, danger may be around the next corner via an  
8 armed criminal (or enemy). In other circumstances the  
9 environment may contain a toxin or other harmful substance.  
10 Still in other circumstances danger may be present via  
11 obstacles, traps, etc. It is often necessary to climb up  
12 stairs, over rugged terrain or through an unfriendly  
13 environment in order to get to an area to be reconnoitered.  
14 Awareness of precise situations is a necessary requirement  
15 to optimize safety in field operations.

16 Present day field reconnaissance apparatus are designed  
17 for basically traveling on a relatively flat surface and,  
18 although they can deliver information back to a surveillance  
19 team, they are limited by their ability to get into  
20 difficult areas, especially when stair climbing is required.

21 What is needed is a simple device that is able to  
22 travel over rugged terrain, climb stairs and carry necessary  
23 visual, audio, sensor equipment as well as payloads. What is

1 needed is a device that is able to arrive at a target area,  
2 reconnoiter an area, and send vital information back to a  
3 reconnaissance team prior to the team entering an area.

4 The present invention solves the aforementioned needs  
5 as will be shown with the following description and  
6 drawings.

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9 **SUMMARY OF THE INVENTION**

10 The main aspect of the present invention is to provide  
11 a reconnaissance apparatus with stair-climbing capability.

12 Another aspect of the present invention is to provide a  
13 reconnaissance apparatus that can traverse over steep and  
14 rugged terrain.

15 Another aspect of the present invention is to provide  
16 an apparatus, which is designed with transposable bottom and  
17 back surfaces to maintain its function when either section  
18 is "flipped-over" to a position making it redundant to a  
19 "normal" position.

20 Another aspect of the present invention is to provide a  
21 reconnaissance apparatus that can be manufactured at low  
22 cost.

1        Yet another aspect of the present invention is to  
2 provide a reconnaissance apparatus that is small in size yet  
3 strong and ruggedly built.

4        Another aspect of the present invention is to provide a  
5 reconnaissance apparatus that is environmentally packaged.

6        Another aspect of the present invention is to provide a  
7 reconnaissance apparatus that is able to carry audio,  
8 visual, and/or a payload or other sensors.

9        Another aspect of the present invention is to provide a  
10 reconnaissance apparatus that can be packaged and easily man  
11 transported to an area of interest.

12       Other aspects of this invention will appear from the  
13 following description and appended claims, reference being  
14 made to the accompanying drawings forming a part of this  
15 specification wherein like reference characters designate  
16 corresponding parts in the several views.

17       The present invention provides a rugged terrain robot  
18 (RTR) that can be employed for reconnaissance in urban or  
19 other environments allowing police, firemen, soldiers, swat  
20 teams or other search and rescue personnel to easily  
21 reconnoiter an area. The RTR provided by the present  
22 invention is small in size and can operate as a stand-alone  
23 robot or as a mission robot that can be deployed from a

1 larger robot. The RTR consists of two clamshell sections and  
2 a tail boom. Clamshell sections of the RTR use a polymorphic  
3 locomotion for efficient maneuverability over rubble in  
4 traversing rugged terrain when in a "rolling" mode.  
5 Clamshell sections are locked together, and the RTR uses a  
6 tail boom assist when in a "stair-climbing" mode.

7 The RTR is designed to carry an infrared camera and  
8 microphone, which are mounted on the tail boom section, for  
9 audio and visual feedback. The RTR also has room for other  
10 type sensors (gas detectors, biological weapons, toxic  
11 materials, etc.), weapons (lethal or non-lethal), audio  
12 equipment, manipulators, tools, and/or payload, which can be  
13 selectively tailored on an "as needed" basis to fulfill  
14 mission requirements. A precise picture and awareness of an  
15 operational environment can be obtained with the use of the  
16 RTR mobile apparatus. Further enhancement of an operational  
17 environment can be obtained with the use of a plurality of  
18 RTRs. The RTR will provide a useful alternative to optimize  
19 the safety of personnel in high-risk situations.

20 The RTR is small, easily carried to a site via a car,  
21 trunk, backpack, etc. and is easily manufactured with a low  
22 cost.

1        Other features and advantages of the invention will  
2        become apparent from a consideration of the ensuing detailed  
3        description and drawings.

4        The RTR of the present invention is a reconnaissance  
5        apparatus with stair-climbing and rugged terrain capability.  
6        The RTR is designed to traverse over steep and rugged  
7        terrain and climb a stairway. The RTR is designed to be  
8        remotely directed for speed, steering, climbing, and  
9        optional communications in a non-tethered fashion. The RTR  
10       is also equipped with a camera, audio/video transmitter, and  
11       can also be equipped with other sensors, speaker, payload,  
12       or other equipment as required. The RTR is small in size and  
13       is, thus, easily transportable to an area to be  
14       reconnoitered. It can be transported to an area via a car  
15       trunk, a backpack, or simply hand carried. The RTR can  
16       operate as a stand-alone unit or as a mission module. A  
17       mission module is defined herein as one that can be deployed  
18       from a larger robot depending on mission requirements.

19       The RTR uses a type of polymorphic locomotion system,  
20       which gives it the ability to act as a wheeled robot to  
21       quickly traverse moderately rugged terrain, and has a stair-  
22       climbing mode for efficient maneuverability in climbing  
23       steps (stairs) or in specific rugged terrain situations that

1 present a step like barrier. Thus, the RTR can traverse a  
2 wide range of environmental conditions such as steps,  
3 building obstacles, debris, level ground, compound slopes,  
4 sand, rocks, ice, and other surfaces.

5 Several features of the RTR include, but not limited  
6 to:

- 7 1. Ability to travel in a switchable "rolling"  
8 mode or in a "stair-climbing mode" via remote  
9 control;
- 10 2. Ability to climb stairs via a unique tail boom  
11 assist;
- 12 3. Self righting with the ability to change to  
13 the most efficient locomotion dependent on the  
14 terrain;
- 15 4. Designed to be able to travel independent  
16 without regard to a specific "top" or "bottom"  
17 surface to the ground;
- 18 5. Ability to move quickly as a wheel driven  
19 robot or a stair climber;
- 20 6. Ability to carry and transmit video/audio via  
21 a camera (infrared or other) and microphone;

- 1        7.        Ability to carry sensors, payloads, audio (one  
2                    or two-way), manipulators, tools as determined  
3                    by the mission requirements;
- 4        8.        Designed with a base section consisting of a  
5                    left and right clamshell design each with  
6                    forward/reverse features for steering, skid  
7                    steering, manipulation out of trouble spots,  
8                    or locking together for stair-climbing;
- 9        9.        Designed with a controllable tail boom section  
10                   for stair climbing assist and for carrying a  
11                   pod to house a camera and other equipment;
- 12       10.       Designed with a unique rotatable axle housing  
13                   to maintain all four drive wheels on the  
14                   ground when in rolling mode and move the tail  
15                   boom to a desired position;
- 16       11.       Ability to overcome common hang-up or nose-in  
17                   failures;
- 18       12.       Ability to perform reconnaissance in  
19                   activities in order to optimize safety in  
20                   situations that could normally be hazardous to  
21                   humans;
- 22       13.       Small in size for ease of transport,  
23                   manipulation in small areas;



1           14.       Low in cost, especially important if mission  
2                       payloads were destructible;

3           15.       Other features are not necessarily mentioned  
4                       but can be implied via the design and  
5                       capabilities of the RTR as described below in  
6                       the description and drawings.

7           The RTR design has a base consisting of two clamshells,  
8 each with two segments, and a tail boom. Each clamshell has  
9 two wheels attached. Each individual clamshell consists of  
10 two clamshell half segments that are designed to be one  
11 common manufacturable housing part number. The clamshells  
12 are connected together by a tail drive unit, to which the  
13 tail boom attaches. The RTR functions in two modes: simple  
14 rolling mode or stair-climbing (or extreme terrain) mode.

15           Each clamshell housing consists of a top and bottom  
16 clam shaped half segment that easily fit together. Each  
17 clamshell has two outer drive wheels attached. The internal  
18 drive motors, one within each clamshell segment, directly  
19 drive one of each of the two attached wheels, whereas a  
20 polymer drive belt (could also be a chain driven belt, etc.)  
21 drives the second wheel. Each clamshell also contains  
22 rechargeable batteries such as Lithium Ion, Nickel Metal  
23 Hydride, Nickel Cadmium, etc. Other internal parts consist

1 of wheel axles, bearings, drive belt, motor holding  
2 bracket(s), a multi-channel receiver, motor drive controls,  
3 tail boom servo control, etc. Each clamshell segment  
4 contains compartments for batteries, motor(s), payload,  
5 servo, receivers, etc. A tail drive motor is also located  
6 within one of the two clamshells. The tail drive motor  
7 operates the tail boom. The tail drive motor and assembly  
8 will be discussed below. Each clamshell is environmentally  
9 packaged and low in manufacturing cost. One internally  
10 located receiver will control all three motors and the  
11 locking servo, whereas a second internally located receiver  
12 may control the tail boom camera.

13       The two clamshell assemblies are connected together by  
14 a tail assembly. The tail assembly consists of a tail boom  
15 arm assembly, onto which mounts a camera and other equipment  
16 as required (sensors, audio, etc.). The tail boom assembly  
17 consists of a top and bottom section. Although a single boom  
18 design can be employed, a two-section tail boom design  
19 allows ease of portability. The lower tail boom section  
20 mounts to a center axle hub block. The center axle hub block  
21 functions to mount an interconnect central axle shaft, the  
22 tail boom arm, axle bearings, gears, a suspension arm for  
23 limiting tail boom rotation, a locking cam to lock both

1 clamshells together, etc. The center axle hub block provides  
2 connectivity for the interconnect central axle, which is  
3 rigidly affixed to one of the clamshells and is allowed to  
4 rotate at the other clamshell. The interconnect central axle  
5 is hollow to facilitate wire inter-connectivity between the  
6 two clamshells. The interconnect central axle has a  
7 suspension arm rigidly attached. The suspension arm  
8 functions to both limit the tail boom travel when in rolling  
9 mode and provides a locking surface to a servo controllable  
10 locking cam to interlock both clamshells when in stair-  
11 climbing mode.

12       Each clamshell and respective primary drive units are  
13 free to rotate relative to each other via the suspension arm  
14 and interconnect central axle when the RTR is in the rolling  
15 mode. Although other rotational limits are possible, the  
16 suspension arm limits each clamshell rotation to about 45-  
17 degrees, which has been found to be beneficial in climbing  
18 over rugged terrain. The tail boom will normally be in an  
19 upright position when in the rolling mode. The tail boom can  
20 be placed in any incremental mode throughout about a 180°  
21 movement from full forward (to allow the camera to look  
22 down) through upright (to allow the camera to look straight  
23 ahead) and to full back (to allow the camera to look up).

1 With this control, the camera can be used to pan in various  
2 angles using the RTR position for moving and observing left  
3 or right. For example its control movement will allow the  
4 camera to look down into a hole or look up under an object  
5 such as under a vehicle. The preferred embodiment of the  
6 present invention is to have the camera mounted in a fixed  
7 position on the boom. An alternate embodiment would be to  
8 have a servo attached to the camera mount for separate  
9 movement of the camera, although testing has found this not  
10 to be necessary.

11 When the RTR is in the stair-climbing mode, the  
12 clamshells (and thus the primary drive units) are locked  
13 together. A servo, located within one of the clamshells,  
14 will be activated via the remote control from the multi-  
15 channel receiver and will move the locking cam into a "lock"  
16 position to contact the suspension arm on the central axle.  
17 In this "lock" position, the central axle will rigidly  
18 parallel-lock both clamshells. This locking action will  
19 ready the RTR for the stair-climbing mode (or extreme  
20 terrain mode). To get back into the rolling mode, the servo  
21 will move the locking cam away from the suspension arm,  
22 which will put the RTR into the rolling mode position,  
23 allowing the suspension arm and central axle to rotate. It

1 may also be desirable to place the clamshells in a lock  
2 position when moving over smooth or off camber terrain, in  
3 which case, the "lock" position can be activated.

4 In the stair-climbing mode, the tail boom is driven  
5 down towards the rear of the RTR and into the surface plane.  
6 Putting the tail boom into stair-climbing mode will only be  
7 possible when the clamshells are in the locked mode. In this  
8 position the camera lens will permit the camera to look 'up  
9 the stairs' or 'up the extreme terrain'. Stair-climbing mode  
10 requires an approximate 10% of total forward driving wheel  
11 torque. This will compensate for various step dimensions and  
12 also assists in the panning of the clamshells during  
13 climbing. When the forward wheels contact a stair riser,  
14 this downward action of the tail boom rotates the clamshells  
15 (parallel-locked) to rotate the rearmost wheels in an upward  
16 direction moving the locked clamshells end-over-end until  
17 the rearmost wheels rotate onto the higher stair, become the  
18 foremost wheels, and then pull the RTR upward to the next  
19 stair. This type of RTR "panning", or end-over-end, movement  
20 moves the apparatus up the stairway. Thus, the tail drive  
21 motor functions to move the tail axle block, and thus the  
22 tail boom in a radial movement about the central axle and  
23 downward to the ground surface in assisting the RTR in

1 climbing stairs. The tail drive motor is connected to the  
2 axle block via bevel gears and will move the central axle,  
3 and thus the tail boom, upon command. When climbing stairs  
4 the tail boom is down and the camera is mounted to look "up"  
5 the stairway. The camera lens is such that the wide angle of  
6 view allows the observation of the RTR from behind the  
7 locked clamshells.

8       The upper tail boom section contains a tail boom pod to  
9 house an infrared camera (or other type camera) and other  
10 aforementioned equipment. In the preferred embodiment of the  
11 present invention the camera is rigidly mounted to the boom  
12 pod. In an alternate embodiment, the camera is gimbaled  
13 mounted within the tail boom pod. The tail boom pod, which  
14 sits on the end of the tail boom, contains a clear enclosure  
15 through which the camera can take, and transmit, visual  
16 images. The camera will pan straight out with about a 110°  
17 field of view from the boom. When in stair-climbing mode it  
18 will be able to view along the tail boom towards the  
19 clamshell base, which would allow visual feedback upward  
20 along the stairs. Horizontal scanning (or panning) left to  
21 right is accomplished by turning the RTR itself. The RTR can  
22 also be turned in a very small pivot via skid steering. That  
23 is, one drive motor can lock one set of clamshell wheels in

1 place while moving the other set in a forward or reverse  
2 direction. The RTR can also rotate in a small circle by  
3 driving one clamshell in a forward motion and the other  
4 clamshell in a reverse motion. Normal steering is  
5 accomplished by moving one wheel drive assembly faster (or  
6 slower) than the other wheel drive assembly. In the stair-  
7 climbing mode, the camera lens field of view will allow the  
8 camera to look down along the tail, allowing site along the  
9 platform and what lies ahead. In the stair-climbing mode  
10 both clamshells are locked in place, and the tail boom will  
11 be in a low position with a downward force relative to the  
12 movement of the locked clamshells. As previously mentioned,  
13 an alternate embodiment would be to gimbaled-mount the  
14 camera using servo controls for its movement although  
15 preliminary tests have shown this not to be required.

16       There are two switches that are used for stair  
17 climbing. One switch will "lock" the clamshells. As  
18 aforementioned, it may be desirable to lock the clamshells  
19 when moving over smooth or off camber terrain when not in  
20 stair climbing (S/C) mode. The second switch "S/C mode" will  
21 move the boom into its S/C assist mode. The second switch  
22 would only activate the boom if the first switch is  
23 activated, that is, if the clamshells are in a "locked"

1 position. As there is a time delay, which is required to  
2 lock the clamshells prior to activating the tail boom into  
3 stair-climbing mode, other alternate embodiments of the  
4 present invention could put an electrical or mechanical time  
5 delay between locking the clamshells and activating the tail  
6 boom. With such an electrical or mechanical delay, it would  
7 be possible to have one switch control stair-climbing mode  
8 by sequencing the locking of the clamshells followed by the  
9 tail boom activation.

10       The tail boom section will feed back a visual image  
11 from the camera along with an audio signal via an  
12 audio/video transmitter located in the tail boom pod. An  
13 optional feature of the RTR would be to have a receiver and  
14 microphone also located in the tail boom pod allowing for  
15 two-way communications with any person(s) in the vicinity of  
16 the RTR.

17       A non-tethered remote control with a visual display,  
18 speaker, camera servo control, joystick (or other) and motor  
19 controls, optional microphone, will allow field personnel  
20 full remote control of the RTR in reconnaissance missions.  
21 The remote control will have a clamshell locking mode switch  
22 to lock the clamshells prior to stair-climbing mode  
23 (clamshells may also be locked for smooth terrain) or unlock



1 the clamshells when in a rolling mode. The remote control  
2 will also have a stair-climbing mode switch to place the  
3 tail boom in 'climbing assist' mode for RTR stair-climbing.  
4 The remote control will also have a power enable switch and  
5 a battery charger connection for recharging its internal  
6 batteries.

7 In the preferred embodiment of the present invention,  
8 the tail boom a fixed length boom and is removable for both  
9 storage or packing. In an alternate embodiment of the  
10 present invention, the tail boom can be an "extendable" boom  
11 with an additional drive system to control the tail boom  
12 extension length.

13 Other alternate embodiments can include optional  
14 sensors to be mounted on the tail boom, within the tail boom  
15 pod, or within either or both clamshells for sensing toxic  
16 gasses, air quality, temperature, etc. Yet other alternate  
17 embodiments can contain a speaker in the tail boom and a  
18 microphone in the remote for two-way communications. It  
19 should be noted that other devices, sensors, manipulators,  
20 tools or other payload can be added as needed to fulfill a  
21 mission requirement.

22 The previously described RTR is a symmetric design and,  
23 thus, can operate without regard to a "top-to-bottom"

1 function that is with either side up if it is flipped over  
2 or as it moves end-over-end when in stair climbing mode.

3 The RTR, with the tail boom rotated back and the camera  
4 looking upward; can easily fit under a vehicle for  
5 inspection of potentially hazardous conditions.

6 The RTR can be manufactured at low cost due, has very  
7 few parts and can, thus, be deployed with a destructive  
8 payload if necessary. The RTR can be constructed in various  
9 sizes to accommodate design or mission requirements.

10 The RTR provides a reconnaissance apparatus that is  
11 small in size yet strong and ruggedly built to traverse a  
12 wide variety of terrain more efficiently than single  
13 locomotion robots and is able to stair climb or climb a  
14 heavy and rugged slope. The RTR is environmentally packaged  
15 to hold up to weather, mud and other harsh environments. It  
16 can be easily carried within the trunk of a vehicle or  
17 manually carried into a site.

18 The ability to carry audio, visual, sensors, and/or a  
19 payload across rugged terrain and up a stairway gives a  
20 reconnaissance team great flexibility and optimized safety  
21 in carrying out a mission allowing for protection of the  
22 team by sending the RTR ahead in order to reconnoiter an  
23 area. As previously discussed, audio equipment can be

1 attached to allow communication as required with unfriendly  
2 forces, trapped individual(s) or other needs.

3 As a mission robot, the RTR can be carried and can be  
4 deployed from a larger robot. A plurality of RTRs can be  
5 deployed for reconnoitering a larger area.

6 The RTR is designed to be manually transported in a  
7 backpack-carrying package such that the RTR can be easily  
8 unpackaged for reconnaissance. The control unit can be kept  
9 in a backpack while allowing the individual to operate the  
10 RTR while the control individual is in a mobile mode.

11 The RTR can be manufactured in various sizes depending  
12 on requirements. A typical packaging size of the clamshell  
13 area (without the boom attached) for normal stair-climbing  
14 and extreme terrain would be in the range of about 19.5" in  
15 width, 13.5" in length and about 5.25" in height for the  
16 preferred embodiment of the present invention with a tail  
17 boom of about 20" from the center of the axle. . The weight  
18 would be about 15.5 pounds. A typical control unit would be  
19 weigh about 8.5 pounds or less. Thus the total weight would  
20 be 24 pounds or less, which is easily transportable by  
21 backpack. A control unit would easily fit within a 19" by  
22 12" by 7" carrying pack volume. The tire diameter in the  
23 preferred embodiment is about 5.25".

1       A smaller size RTR can be built for specific needs. For  
2       example, a lighter weight (8.5 pound) unit with dimensions  
3       of about 10" x 7" x 3" could be manipulated for  
4       reconnaissance within very small areas. Larger RTRs could  
5       also be built for other required conditions. .

6       The RTR will provide law enforcement agencies, search  
7       and rescue teams, swat teams, soldiers, and other agencies a  
8       flexible tool to optimize the safety of the team in  
9       conditions that warrant a send-ahead robot to reconnoiter an  
10      area.

11

#### 12                   **BRIEF DESCRIPTION OF THE DRAWINGS**

13       Figs. 1A, 1B are a side perspective views showing a  
14      configuration of a prior art robot.

15       Fig. 2 is a side perspective view of the RTR, the  
16      preferred embodiment of the present invention.

17       Fig. 3 is a front perspective exploded view of the RTR  
18      shown above in Fig. 2.

19       Fig. 4 is a further front perspective exploded view of  
20      left most clamshell section from Fig. 3.

21       Fig. 5 is a further front perspective exploded view of  
22      the tail boom and part of the leftmost clamshell from Fig. 3  
23      above.

1        Fig. 6 is a further front perspective exploded view of  
2        the tail boom and the rightmost clamshell section from Fig.  
3        3 above.

4        Fig. 7 is a front perspective view of the RTR in motion  
5        over rugged terrain.

6        Figs. 8a through 8e depict the RTR moving over an  
7        obstacle in rugged terrain.

8        Figs. 9a through 9g depict the RTR approaching and then  
9        climbing a set of stairs.

10       Fig. 10 is an illustrative view of the RTR upper tail  
11       boom with tail boom pod and tail boom pod contents.

12       Fig. 11 is a front perspective view of the RTR remote  
13       control unit (RCU) packaged in an individual encasement, an  
14       alternate packaging embodiment.

15       Fig. 12 is a rear perspective view of the RCU shown in  
16       Fig. 11, an alternate packaging embodiment.

17       Fig. 13 is a block diagram of the electronics in the  
18       RTR and the RCU.

19       Fig. 14A is a rear perspective view of a backpack  
20       carrying package, the preferred packaging embodiment of the  
21       present invention.

1        Fig. 14B is a front perspective view of a backpack  
2        carrying package, the preferred packaging embodiment of the  
3        present invention.

4        Fig. 15 is a front perspective view of the RCU backpack  
5        in an unattached and open state.

6        Fig. 16 is a rear perspective view of the RCU backpack  
7        in an unattached and open state.

8        Fig. 17 is a front perspective view of the RTR backpack  
9        carrier.

10       Fig. 18 is a front perspective drawing of the RTR with  
11       a telescopic tail boom in a collapsed position, an alternate  
12       embodiment of the present invention.

13       Fig. 19 is a front perspective drawing of the RTR with  
14       a telescopic tail boom in an extended position, an alternate  
15       embodiment of the present invention.

16       Fig. 19a is a cut out sectional blow-up view of the  
17       worm gear and worm gear servomotor of section-A of Fig. 19.

18       Fig. 20 is a front perspective drawing of the RTR with  
19       an alternate paddle wheel configuration, an alternate  
20       embodiment of the present invention.

21       Fig. 21 is a front perspective drawing of the RTR with  
22       an alternate non-driven disk wheel configuration, another  
23       alternate embodiment of the present invention.

1        Fig. 22a is a rear perspective drawing of a laptop  
2 control unit, an alternate body of the present invention.

3        Fig. 22b is a front perspective drawing of a laptop  
4 control unit, an alternate embodiment of the present  
5 invention.

6        Before explaining the disclosed embodiment of the  
7 present invention in detail, it is to be understood that the  
8 invention is not limited in its application to the details  
9 of the particular arrangement shown, since the invention is  
10 capable of other embodiments. Also, the terminology used  
11 herein is for the purpose of description and not of  
12 limitation.

13

#### 14                    **Detailed Description of Drawings**

15

16        Figs. 1A, 1B is an isometric perspective view showing a  
17 configuration of a prior art robot **200** with two  
18 independently moving sides **204, 205**. Typical prior art  
19 robots can employ camera(s) **201** for visual feedback, have a  
20 top surface **203** and a bottom surface **202**, and can carry a  
21 payload on top surface **203** or internally. A limitation of  
22 prior art robot **200** is that it can only operate in a  
23 position such that top surface **203** is always "up" due to

1 wheel clearance. Another limitation of robot **200** is that it  
2 cannot climb stairs, and is limited in camera feedback due to  
3 height from ground, and may typically be too heavy or  
4 cumbersome to be carried. If robot **200** were to be flipped  
5 "head-over-heels", it would be inoperable.

6 Fig. 2 is a side perspective view of RTR **100**, the  
7 present invention. RTR **100** consists of two clamshell  
8 sections **1a**, **1b**, which are symmetrical and nearly identical  
9 in design and manufacturing. Each clamshell section **1a**, **1b**,  
10 consists of top and bottom sections that are also identical  
11 parts. Thus, only one part number is manufactured to create  
12 both clamshells **1a**, **1b**. Four wheels **4** are mounted to RTR **100**  
13 clamshells, each wheel **4** having outer wheel treads **47**. The  
14 tail boom consists of upper tail boom section **22** and lower  
15 tail boom section **49**. Lower tail boom section **49** connects to  
16 central axle hub block **19**. Tail boom pod **26**, with clear  
17 enclosure **48**, holds various apparatus such as a camera,  
18 audio/video camera antenna, transmitter, along with optional  
19 items such as a microphone, payload, speaker, sensors, etc.  
20 Although not limited to specific dimensions or weight, RTR  
21 **100** clamshells can easily be designed to fit within a one by  
22 one foot length and width and weigh less than eight pounds.



1 With a sectional tail boom for separation during transport,  
2 it is easily carried to a reconnaissance site. Base load  
3 antenna **15** receives input command signals from the remote  
4 control. Base load antenna **15** could also be packaged in  
5 other locations such as at the top of the tail boom. It  
6 should also be noted that tire configurations, other than  
7 that depicted, could also be employed such as smooth  
8 surface, knobby, or all terrain tire surfaces.

9 An alternate embodiment of the present invention could  
10 also employ a magnetic tire surface to assist the RTR with  
11 the ability to navigate on the undersurface of a ferrous  
12 type material such as climbing over and under a tank.

13 Fig. 3 is a perspective blow up view of RTR **100** shown  
14 above in Fig. 2. Each wheel **4** connects to respective wheel  
15 axle **5**. Bearings **2** support each wheel within the clamshell.  
16 Mounted on each wheel axle **5** is belt gear **6** for driving  
17 wheel drive belt **8**. Wheel drive motor **3** drives belt gear **6**,  
18 and thus wheel belt **8**. Wheel belt **8** could be fabricated with  
19 fiber, rubber, metal or other various materials. Clamshell  
20 half sections **1** are all identical parts and can be made of  
21 materials such as nylon or other polymer type materials. Ten  
22 batteries **12** are serially coupled and packaged within the  
23 clamshells. Batteries employed in the preferred embodiment

1 are 1.2vdc (12vdc total) although other power configurations  
2 are possible. Motor controllers **10** are individually coupled  
3 to multi-channel receiver **11**, through which controls to all  
4 motors and cam lock servo **13** are performed. Upper tail boom  
5 section **22** and lower tail boom section **49** connect to central  
6 axle hub block **19**. Tail boom pod **26** attaches to upper tail  
7 boom section **22**, and has clear enclosure **48**. The tail boom  
8 (tail boom sections **22**, **49**) is controlled in its rotational  
9 movement by tail motor drive **17**, and bevel gear **18** connected  
10 to drive gear **20** via central bearing connection **16**. Tail  
11 motor drive **17** is attached to clamshell half section **1** via  
12 motor bracket **7**. Interconnect central axle **23** is hollow to  
13 allow wiring inter-connectivity between both clamshells.  
14 Interconnect central axle **23** is rigidly affixed to one  
15 clamshell (leftmost clamshell shown) and has suspension arm  
16 **24** affixed to its opposite end. Suspension arm **24** allows one  
17 clamshell to rotate freely with respect to the other  
18 clamshell within about a 45-degree rotation. This movement  
19 allows RTR **100** to move about rugged terrain. Lock cam **25** is  
20 pivotally attached to the rightmost clamshell shown and  
21 allowed to pivot to an "up" or "down" position via cam lock  
22 servo **13** control. When in an "up" position lock cam **25**

1 (shown in an up position) locks suspension arm **24**, and thus  
2 interconnect central axle **23**. This "up" lock position locks  
3 both clamshells together and is used in the "stair-climbing"  
4 mode. When lock cam **25** is in the "down" position (rolling  
5 mode), the clamshells can rotate with respect to one another  
6 for moving over rugged terrain. It should be noted that  
7 various lock cam configurations could be employed to  
8 accomplish the same locking function on the cams. For  
9 example, a linear cam design (not shown) could easily  
10 perform the same locking function. Slip ring bearings **21**  
11 allow rotation of central axle hub block **19** to be  
12 independent of interconnect central axle **23**. Cam lock servo  
13 **13** controls the position of lock cam **25**. Base load antenna  
14 **15** receives control signals from the remote control device  
15 (not shown).

16 Fig. 4 is a further front perspective blow-up view of  
17 one clamshell section **101**, the leftmost clamshell depicted  
18 in Fig. 3 above, showing the wheels and wheel drive  
19 mechanisms. Each wheel **4** has outer wheel treads **47** and each  
20 wheel **4** connects to respective wheel axle **5**. Bearings **2** sit  
21 into clamshell half **1** cavities to support wheel axle **5**.  
22 Mounted on each wheel axle **5** is belt gear **6**, which drives

1 wheel drive belt 8. Wheel drive motor 3 is mounted within  
2 lower clamshell half 1 via motor bracket 7 and directly  
3 drives one belt gear 6. Belt tensioner 9 allows belt tension  
4 adjustment. Clamshell half 1 sections 1 are identical parts  
5 and can be made of a nylon or polymer type or other such  
6 material. Batteries 12 are serially coupled and packaged  
7 within the clamshells. Motor controllers 10 are coupled to a  
8 multi-channel receiver in the other clamshell section (not  
9 shown).

10 Fig. 5 is a further front perspective blow-up view of  
11 the tail boom sections and rightmost part of the leftmost  
12 clamshell 101 from Fig. 3 above. Upper tail boom section 22,  
13 which has clear enclosure 48, connects to lower tail boom  
14 section 49, which in turn connects to central axle hub block  
15 19. Tail boom pod 26 attaches to upper tail boom section 22.  
16 The tail boom is controlled in its rotational movement R by  
17 tail motor drive 17, and bevel gear 18 connected to drive  
18 gear 20 via central bearing connection 16. Tail motor drive  
19 17 connects to half clamshell section a via motor bracket 7.  
20 Interconnect central axle 23 is hollow to allow wiring (not  
21 shown) inter-connectivity between both clamshells.

1 Interconnect central axle 23 is rigidly affixed to one  
2 clamshell (leftmost clamshell shown) and has suspension arm  
3 24 affixed to its opposite end. Lock cam 25 is pivotally  
4 attached to the rightmost clamshell (not shown) and allowed  
5 to pivot to an "up" or "down" position via cam lock servo 13  
6 control (not shown). Suspension arm 24 allows one clamshell  
7 to rotate freely with respect to the other clamshell within  
8 about a 45-degree rotation when lock cam 25 is not engaged.  
9 This movement allows RTR 100 to move about rugged terrain.  
10 When in an "up" position lock cam 25 (shown in an up  
11 position) locks suspension arm 24, and thus interconnect  
12 central axle 23. This "up" lock position locks both  
13 clamshells together and is used in the "stair-climbing"  
14 mode. When lock cam 25 is in the "down" position (rolling  
15 mode), the clamshells can rotate with respect to one another  
16 for moving over rugged terrain. Slip ring bearings 21 allow  
17 rotation of central axle hub block 19 to be independent of  
18 interconnect central axle 23. Slip ring bearings 21 also  
19 allow power to be transferred and distributed into the  
20 rotatable tail boom. Soldering or welding one power wire  
21 connection into the inner bearing hub and allowing it to

1 transfer to another conductor, which is soldered/welded to  
2 the outer bearing hub, through the ball bearings,  
3 accomplishes this. In such a manner bearings 21 each  
4 respectively transfer either a plus or a minus dc-power  
5 conductor into the tail boom. An internal boom electrical  
6 connector (not shown) allows tail boom upper section 22 and  
7 tail boom lower section 49 to be physically disconnected.  
8 Recharging of batteries can be accomplished via the  
9 electrical connector, attached to tail boom lower section  
10 49.

11 Fig. 6 is a further front perspective blow-up view of  
12 the tail boom and the rightmost clamshell section 102 from  
13 Fig. 3 above. Interconnect central axle 23 is rigidly  
14 affixed to the leftmost clamshell floats within the  
15 rightmost clamshell and has suspension arm 24 affixed to its  
16 rightmost end. It allows one clamshell to rotate freely with  
17 respect to the other clamshell within about a 45-degree  
18 rotation. This movement allows RTR 100 to move about rugged  
19 terrain. When in an "up" position lock cam 25 (shown in an  
20 up position) locks suspension arm 24, and thus interconnect  
21 central axle 23. This "up" lock position locks both

1    clamshells together and is used in the "stair-climbing"  
2    mode. When lock cam 25 is in the "down" position (rolling  
3    mode), the clamshells can rotate with respect to one another  
4    for moving over rugged terrain. Bearings 21 allow rotation  
5    of central axle hub block 19 to be independent of  
6    interconnect central axle 23. Cam lock servo 13 controls the  
7    position of lock cam 25 by way of servo link 14. Base load  
8    antenna 15 receives control signals from the remote control  
9    device (not shown). Wheel drive motor 3 drives wheels 4 as  
10   previously described. Multi-band receiver pack 11 receives  
11   remote signals and sends separate control signals to each  
12   motor controller 10 and cam lock servo 13.

13        Fig. 7 is a front perspective view of RTR 100 in motion  
14   over rugged terrain. As wheels 4 move over rugged terrain T,  
15   each individual clamshell section 1a, 1b is allowed to  
16   rotate with respect to the other. The tail boom is moved to  
17   an upright position (shown) allowing the boom-mounted camera  
18   within tail boom pod 26 to send images as seen through clear  
19   enclosure 48. Outer wheel treads 47 prevent slippage of  
20   tires 4. Load antenna 15 receives control signals from the  
21   remote control device (not shown).

1 Figs. 8a through 8e depict RTR **100** moving over obstacle  
2 **102** in rugged terrain. As RTR **100** approaches obstacle **102** in  
3 rolling mode, Fig. 8a, the left clamshell wheel sequentially  
4 rotates up, on top of, and over obstacle **102** (Figs. 8b, 8c,  
5 8d, 8e). One clamshell section can be seen rotating with  
6 respect to the opposite clamshell section as RTR **100** climbs  
7 over obstacle **102** in rolling mode. The tail boom is in an up  
8 position to allow maximum viewing of what lies ahead.

9 Figs. 9a through 9g depict RTR **100** of the present  
10 invention approaching and then climbing stairway **103**. With  
11 RTR **100** placed in a "stair-climbing" mode, both clamshells  
12 are locked parallel to one another as previously described.  
13 The camera is panned to look down the tail boom. The tail  
14 boom is controlled in a downward position and with a  
15 continued downward boom force **F** applying pressure of the  
16 tail boom into surface **S**. During the stair climbing  
17 process, the wheels will simultaneously slowly drive  
18 forward, keeping a positive forward force required for the  
19 stair climbing motion. As RTR **100** approaches the base of  
20 stairway **103** (Fig. 9a) the set of RTR **100** foremost wheels  
21 **104** encounter step one riser (Fig. 9b) of stairway **103**.



1 Downward tail boom force  $F$  and RTR 100 foremost wheels 104  
2 traction lift the rear wheels 105 off surface  $S$  (Fig. 9c) in  
3 a rotational end-over-end movement until the rearmost wheels  
4 105 flop over to the top of step one (Fig. 9d), at which  
5 time rearmost wheels 105 become the forward drive wheels.  
6 Wheels 105 then provide traction and, along with continued  
7 downward tail boom force  $F$ , pull the opposite set of wheels  
8 104 upward along stairway 103 (Fig. 9e) in an end-over-end  
9 rotational manner until wheels 105 (now forward) move RTR  
10 100 to the base of step two riser (Fig. 9f) and wheels 104  
11 rotate to contact the top of step two (Fig. 9g) pulling RTR  
12 up to step two. RTR 100 will continue to climb stairway 103  
13 in the aforementioned end-over-end manner until stairway 103  
14 is traversed, at which time RTR 100 can be placed into  
15 "rolling" mode as previously described. When RTR 100 is  
16 going down a stairway, it can be placed in either rolling or  
17 stair-climbing mode.

18 Fig. 10 is an illustrative view of RTR 100 upper tail  
19 boom 103 and tail boom pod 26 contents. Pod mounting bracket  
20 50 attaches to upper tail boom 22, has mounting positions  
21 for various equipment, and accepts pod 26, which has clear

1 enclosure 48. Boom receiver antenna 51 receives various  
2 robot control signals and transfers them to boom receiver  
3 pack 52. An alternate embodiment would allow camera 27 to be  
4 directionally controlled with camera gimble servo 29. In the  
5 preferred embodiment of the present invention, camera 27 is  
6 rigidly mounted to the tail boom mounting bracket 50 and  
7 camera gimble servo 29 is not required. Camera 27 transmits  
8 video signals via audio/video (A/V) transmitter 28 and A/V  
9 transmitter antenna 32. Likewise microphone 30 transmits  
10 audio signals via audio/video (A/V) transmitter 28 and A/V  
11 transmitter antenna 32. Optionally pod 26 can contain a  
12 speaker 34 to receive audio signals from the remote control  
13 through audio receiver antenna 60 and A/V receiver pack 61  
14 in order to facilitate a two-way communication function.  
15 There is also room to package other equipment 31, such as  
16 payloads, sensors to detect toxins, or other type sensors or  
17 other equipment as required by situational needs. An  
18 optional payload receive antenna (not shown) could be added  
19 to receive signals for any payload activation as required.  
20 As previously discussed, use of a wide angle lens, left to  
21 right movement of RTR 100 and incremental "up" or "down"

1 movement of the boom has shown that visual observation can  
2 be adequately done without a separate camera gimble by use  
3 of a camera lens with about 110° field of vision. It should  
4 be noted that although the tail boom pod with camera is  
5 shown mounted at the top of the tail boom, it could also be  
6 mounted at various positions along the tail boom. The camera  
7 could also be placed on or in the clamshell similar to the  
8 prior art camera mount shown in Fig. 1.

9 Fig. 11 is a front perspective view of RTR remote  
10 control unit (RCU) 300 packaged in an individual carrying  
11 case, an alternate embodiment of the RCU packaging of the  
12 present invention. RCU cover 56 has an instructional placard  
13 46 mounted inside. RCU base 55 has a carrying strap  
14 connection 42 on both sides and contains all of the RCU 300  
15 electronics. Surface plate 57 contains power activation  
16 switch 62, A/V receiver pack 38, and command transmitter 35.  
17 Joystick control 36 controls the speed and direction of RTR  
18 100. Clamshell lock/unlock switch 91 will 'lock' or 'unlock'  
19 the clamshells for stair-climbing or rolling modes  
20 respectively. Clamshells must be 'locked' prior to  
21 activating the boom when entering stair-climbing (S/C) mode.  
22 S/C switch 37 will move the tail boom down into climbing

1 assist mode when in one position or allow it to be  
2 controlled by boom control switch **39** in its other position.  
3 RCU speaker **58** allows the user to listen to transmitted RTR  
4 audio signals. Battery charger connection **59** allows remote  
5 battery charging capabilities of internal battery packs. If  
6 RCU **300** is optionally equipped for two-way communication  
7 with RTR **100** then RCU microphone **54** and control/audio  
8 transmitter **40** are included. Area **41** is reserved for payload  
9 control or activation switches. Any additional sensor  
10 information received would be displayed on visual monitor **33**  
11 as overlay information over the visual signal. RCU **300** is  
12 non-tethered and controls RTR **100** via command signal  
13 transmission. In an alternate embodiment a camera gimble  
14 control switch would also be included to allow remote camera  
15 control.

16 Fig. 12 is a rear perspective view of RCU **300** shown  
17 above in Fig. 11. RCU carrying strap **43** attaches to carrying  
18 strap connection **42** on RCU base **55**. At the rear of RCU base  
19 **55** are located three antennae; RCU audio transmitter antenna  
20 **44** for audio communications to the RTR tail boom pod; RCU  
21 A/V receiver antenna **45** to receive A/V signals from the RTR  
22 pod; and RCU base load antenna **53** to transmit control

1 signals to the RTR clamshell base. With RCU cover 56 down,  
2 RCU 300 is easily transported from one location to another.  
3 RCU 300 thus allows personnel to directly control RTR 100  
4 from a remote location and allow RTR 100 to act as a  
5 reconnaissance vehicle in reconnoitering an area of concern,  
6 including the ability of climbing stairways, traversing over  
7 rugged terrain, two-way communicating, carrying payloads,  
8 sensors, etc.

9 Fig. 13 is a block diagram 400 of the electronics in  
10 RTR 100 and RCU 300. Battery charger 401 can be connected to  
11 either or both RCU power battery pack 402 or RTR power  
12 battery pack 12.

13 RCU 300 electronics have been previously described and  
14 consist of: RCU battery pack 12; control/audio transmitter  
15 40; A/V receiver pack 38; Video monitor 33; RCU speaker 58;  
16 RCU A/V receiver antenna 45 and A/V receiver pack 38 to  
17 receive A/V signals RS from the RTR; and RCU transmit  
18 antennae, block 403, to transmit control and audio signals  
19 TS. Antennae within block 403 consist of RCU base load  
20 antenna 53 (see Fig. 12) to transmit control signals to the  
21 RTR clamshell base and an optional RTC audio transmit

1 antenna **44** (see Fig. 12) to transmit audio to the tail boom  
2 pod for two-way communications with the RTR.

3 RTR electronics have been previously described and  
4 consist of electronics both in the tail boom pod and in the  
5 clamshell sections.

6 A RTR battery pack power **12** is enclosed within the base  
7 clamshell sections and provides power to all electronics in  
8 the clamshell sections and transfers power to the tail boom  
9 via slip ring bearings **21** as previously described.

10 The tail boom section has two receive antennae **404** (not  
11 separately shown) to receive control signals **TS**. Receive  
12 antennae **404** consist of boom control receiver antenna **51**  
13 (Fig. 10) to receive control signals for tail boom motor  
14 control and the optional camera gimble and also optional  
15 payload receiver antennae **32a** to receive payload activation  
16 signals (see Fig. 10). Tail boom receiver pack **52** feeds  
17 control signals to boom motor control servo and optional  
18 camera gimble **29** to provide control to camera **27**. Tail boom  
19 A/V transmitter **28** transmits video signals from camera **27**  
20 and audio signals from optional microphone **30**. A/V signals  
21 are sent to RCU **300** via A/V transmit antenna **32**.

1           Clamshell sections receive command signals **TS** through  
2   base load antenna **15** (see Fig. 7) from the RCU for RTR  
3   steering and tail boom movement control. Multi-channel  
4   receiver **11** sends control information to motor controllers  
5   and servo block **405**, which contains the aforementioned motor  
6   controllers **10** and cam lock servo **13**. Each motor controller  
7   **10** then separately controls the three aforementioned drive  
8   motors and the servo controls the movement of the cam lock  
9   mechanism, as depicted all within block **406**.

10          Figs. 14A, 14B illustrate backpack carrying package **800**  
11   which consists of two individual backpacks held together  
12   with a zipper. Fig. 14A is a rear perspective view of  
13   backpack carrying package **800**, the preferred packaging  
14   embodiment of the present invention. Control backpack **63**  
15   houses the remote control unit while RTR backpack carrier **83**  
16   houses the RTR itself. Control backpack antennae holes **92**  
17   (Fig. 14B) permit deployment of control unit antennae when  
18   the control unit is in active use. RTR backpack shoulder  
19   straps **85** allow one individual to carry both units.

20          Fig. 14B is a front perspective view of backpack  
21   carrying package **800**. Control backpack **63** attaches to RTR

1    backpack carrier **83** via a zipper **90** such that both backpacks  
2    can easily be detached from one another.

3        Fig. 15 is a front perspective view of remote control  
4    unit (RCU) backpack **63** in an unattached and open state. That  
5    is, control backpack is shown in a standalone state,  
6    unattached to RTR backpack carrier **83** (not shown) and opened  
7    up to show its internal contents with control backpack cover  
8    **81** unzipped. Although the electronics are identical in  
9    function to the aforementioned RCU **300** case packaging,  
10   individual components are located for the ergonomic usage by  
11   the person carrying RCU backpack **63**. Otherwise, all function  
12   is identical. RCU backpack flap **81** has an instructional  
13   placard **46** mounted inside and contains all of the RCU  
14   electronics. RCU shoulder straps **82** allow for individual  
15   carrying when not attached to RTR backpack carrier **83** (not  
16   shown). Control transmitter **70** is shown along with battery  
17   status indicator **86** and remote control pack power activation  
18   switch **87**. A/V receiver pack **71** and battery **72** are packaged  
19   for easy access along with battery charger input terminal  
20   **90**, which allows remote battery charging capabilities of  
21   internal battery packs. Hand controller **73** is connected to  
22   the RCU via hand controller electrical cord **74** and contains



1 RTR directional/speed joy stick **75**. Hand controller **73** also  
2 contains clamshell lock switch **77** to place the clamshells in  
3 either locked position or in rolling mode. Boom assist mode  
4 (or extreme terrain) activation switch **76** is set in one  
5 position to set the boom in climbing assist mode and in  
6 another position to allow the boom to be independently  
7 controlled by boom control stick switch **80** (see Fig. 16). A  
8 10% or more total forward wheel driving torque is applied  
9 when boom assist mode activation switch **76** is set to  
10 climbing assist mode. Clamshell lock **77** switch must be set  
11 in a 'locked' position in order for boom assist mode  
12 activation switch **76** to be set in climbing assist mode  
13 (which moves the tail boom into a downward direction to  
14 assist the RTR in stair-climbing). Monitor display **68**  
15 (referred to by industry as a "heads up" display), remote  
16 speaker **88**, and microphone **89** are attached to glasses **67** and  
17 electrically attached to the RCU via electrical cord **69**. In  
18 this manner the user can easily see the RTR camera feedback  
19 via monitor display **68**, can use audio via microphone **89**, and  
20 also hear what is transmitted from the RTR via remote  
21 speaker **88**, all while the RTR control person is in a mobile  
22 state. There is also an internal area (not shown) reserved

1 for payload activation switching. Any additional sensor  
2 information received would be visually displayed on monitor  
3 display **68** as overlay information over the visual signal.  
4 The RCU is non-tethered with respect to the RTR and controls  
5 the RTR via command signal transmission. At the top of RCU  
6 backpack **63** are located three antennae; RCU audio  
7 transmitter antenna **66** for audio communications to the RTR  
8 tail boom pod; RCU A/V receiver antenna **65** to receive A/V  
9 signals from the RTR pod; and RCU base load antenna **66** to  
10 transmit control signals to the RTR clamshell base. A camera  
11 gimble control (not shown) would be added to allow remote  
12 camera control.

13 Fig. 16 is a rear perspective view of RCU backpack **63**  
14 in an unattached and open state. Fig. 16 shows power/boom  
15 control box **78**, which is electrically connected to the RCU  
16 via electrical wire **93**. Power/boom control box **78** contains  
17 both a remote RTR power switch **79** (for remote power  
18 activation of the RTR) and also contains boom control **80** for  
19 incrementally moving the tail boom. Remote speaker **88** and  
20 microphone **89** are attached to glasses **67** and electrically  
21 attached to the RCU via electrical cord **69**.

1       With RCU backpack flap **81** zippered up, and RCU either  
2   attached to RTR backpack **83** or directly strapped to a user,  
3   the RCU is easily transported from one location to another.  
4   The RCU thus allows personnel to directly control RTR **100**  
5   from a remote location and also to continuously be in a  
6   mobile state while controlling RTR **100** allowing RTR **100** to  
7   act as a reconnaissance vehicle in reconnoitering an area of  
8   concern. The RTR reconnaissance would constantly include its  
9   ability of climbing stairways, traversing over rugged  
10   terrain, transmitting visual feedback, two-way  
11   communicating, carrying payloads, sensors, etc.

12       Fig. 17 is a front perspective view of RTR backpack  
13   carrier **83** in an opened position with RTR backpack carrier  
14   front flap **84** in a down position and with RTR **100** packed  
15   internally for ease of transport.

16       Fig. 18 is a front perspective drawing of RTR **100** with  
17   a telescopic tail boom in a collapsed position, an alternate  
18   embodiment of the present invention. Telescopic tail boom  
19   consists of base boom section **96**, intermediate boom sections  
20   **97**, **98** and top section **99**. A servomotor (see Fig. 19), which  
21   is located under base boom section **96**, will extend or  
22   collapse all sections via a worm drive (see Fig. 19, 19a).  
23   Tail boom movement is controlled via remote control. With a

1 telescopic tail, the tail boom can be extended, or  
2 collapsed, depending on conditions related to the visual  
3 field or tail boom assist requirements.

4 Fig. 19 is a front perspective drawing of RTR **100** with  
5 the telescopic tail boom in an extended position, an  
6 alternate embodiment of the present invention. In this  
7 extended position, telescopic worm gear servomotor **95** will  
8 control worm drive **120** to extend intermediate sections, **97**  
9 and **98** and top section **99** to either a full extension or  
10 partial extensions as required. Telescopic worm gear  
11 servomotor **95** and worm drive **120** is shown in cross sectional  
12 view (cut out section-A) and again in blow-up illustration  
13 in Fig. 19a.

14 Fig. 20 is a front perspective drawing of RTR **100** with  
15 a 'paddle wheel' configuration, an alternate embodiment of  
16 the present invention. In this configuration wheels are  
17 driven as previously described but each wheel has paddle-  
18 like extensions **121**. This alternate wheel configuration  
19 would be desirable, for example, when crossing water is a  
20 requirement. Each clamshell and the tail boom pod would have  
21 watertight gaskets incorporated along with floatation  
22 assistance such as internal foam. This alternate embodiment  
23 would allow the RTR to travel over ponds, lakes, streams and

1 the like for reconnaissance missions with water travel  
2 requirements.

3 Fig. 21 is a front perspective drawing of RTR **100** with  
4 an alternate non-driven 'disk support' configuration,  
5 another alternate embodiment of the present invention. In  
6 this configuration disk supports **122** would be rigidly  
7 attached (non-rotatable) to RTR **100** but not be driven by any  
8 motor. In this configuration RTR **100** would be in the  
9 aforementioned and described 'stair-climbing' mode. Thus the  
10 clamshells would be locked together, the tail boom would be  
11 moved down into the rear plane surface, and the RTR would be  
12 panning along a surface for movement across an open area and  
13 also rotate or 'pan' when climbing over extreme terrain or  
14 stair climbing.

15 Fig. 22a is a rear perspective drawing of laptop  
16 control unit **300**, an alternate body of the present  
17 invention. In this configuration a cable attachment (PC-  
18 parallel, USB, or other standard PC connection would attach  
19 transmitter/receiver **125** with antenna **124** to laptop PC **123**.

20 Fig. 22b is a front perspective drawing of a laptop  
21 control unit **300**, an alternate embodiment of the present  
22 invention. In this configuration a cable **126** attaches  
23 transmitter/receiver **125** with antenna **124** to laptop PC **123**.

1 Monitor **128** would display the aforementioned camera feedback  
2 PC **123** would have a standard keyboard, speaker and  
3 microphone and utilize mouse pad **127** to control the RTR.

4 Thus the RCU and RTR are easily portable with the RTR  
5 easily unpackaged and set into a reconnaissance mode while  
6 under remote control by an individual who is also mobile  
7 during the entire reconnaissance operation.

8 Although the present invention has been described with  
9 reference to preferred embodiments, numerous modifications  
10 and variations can be made and still the result will come  
11 within the scope of the invention. No limitation with  
12 respect to the specific embodiments disclosed herein is  
13 intended or should be inferred.

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